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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/820,068	03/28/2001	Wei Pan	SLA 0493	4042

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David C. Ripma, Patent Counsel
Sharp Laboratories of America, Inc.
5750 NW Pacific Rim Boulevard
Camas, WA 98607

EXAMINER
LUHRS, MICHAEL K

ART UNIT	PAPER NUMBER
2824	

DATE MAILED: 06/05/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

604345

Copy

Office Action Summary	Application No.	Applicant(s)	
	09/820,068	PAN ET AL.	
	Examiner	Art Unit	
	Michael K. Luhrs	2824	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Peri d for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *17 April 2003* .

2a)☒ ~~This action is FINAL~~. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disp sition of Claims

4)☒ Claim(s) *1,2,4-12,21 and 22* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,2,4-12,21 and 22* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *28 March 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☒ Other: *updated search history* .

DETAILED ACTION

Response to Amendment

1. The applicant expresses difference between Itoh et. al.'s plasma and applicant's gas, applicant explicitly reciting a "non-plasma atmosphere" in line 6, claim 1 and non-reactive atmosphere in lines 7-8, claim 21. Examiner agrees that claims 1 and 21,but not claim 9, now overcome Itoh et. al..

Drawings

2. New corrected drawings are suggested in this application for an appearance more suitable for publication. Applicant is advised to employ the services of a competent patent draftsperson outside the Office, as the U.S. Patent and Trademark Office no longer prepares new drawings. The corrected drawings are suggested in reply to the Office action.

3. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claim Rejections - 35 USC § 112

~~4.~~ The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

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5. The specification is objected to because: ~~Claim 22 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.~~

The specification, p. 3 line 9, states "atmosphere chosen from the group consisting of;" however claim 22 states in lines 1- 2, " atmosphere is chosen from the group consisting *essentially* of:". The phrases are not consistent.

Claim Rejections - 35 USC § 102

6. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

7. Claims 1, 2 , 4, 5, and 8 are rejected under 35 U.S.C. 102(e) as being anticipated by Danek et. al. USPN 6,534,404.

Regarding claim 1, a partially finished device is indicated in lines 37-38, column 4 includes a barrier metal layer 32a on substrate 30 (lines 33-34 column 3); subjected to non-plasma atmosphere (Si_2H_6, Si_3H_6, SiH_nX_{4-n} listed in line 7, column 4 are non-plasma) chosen from the group ambient vacuum, hydrogen gas, argon gas or helium gas to which Danek et. al teach of ambient vacuum of 2 torr in lines 40-41, column 2, (hydrogen gas is also contained in any of Si_2H_6, Si_3H_6, SiH_nX_{4-n} listed in line 7, column 4); subjected the barrier layer to temperature greater than 200 degrees as in thermal treatment line 24, column 3, processing temperature 325 degrees in line 61, column 3; copper is subsequently deposited, as indicated in the test example, line 37, column 4.

Regarding claim 2, Danek et. al teach the temperature of 325 degrees in line 61, column 3 for in-situ thermal treatment line 24, column 3 falls in 250-550 range.

Regarding claim 4, Danek et. al teach the pressure of 2 torr for treatment of the barrier in lines 39-41, column 3, falls within 0.1 mtorr-20 torr range.

Regarding claim 5, Danek et. al. teach subjecting the barrier layer to greater than 200 degrees for 30-100 seconds namely 5-60 seconds at 325 degrees as post deposition thermal treatment in lines 51-52, column 3.

Regarding claim 8, Danek et. al. teach barrier metal layer chosen from group consisting of TiN and TaN, since Danek teach TiN and TaN, line 33, column 3 and line 5, column 4.

8. Claims 1, 2, 5, 6, 8, 9, 11, 21 and 22 are rejected under 35 U.S.C. 102(e) as being anticipated by McTeer USPN 6,204,179.

Regarding claim 1, McTeer teaches a partially finished device includes a barrier metal layer, line 24, column 17 on substrate; subjected to non-plasma atmosphere as oxygen or hydrogen are non-plasma, chosen from the group ambient vacuum, hydrogen gas, argon gas or helium gas to which McTeer teach a flowing in gases such as hydrogen gas in line 55, column 17; subjected the barrier layer to temperature greater than 200 degrees as temperature of 700 degrees or less lines 44-45, column 17; copper 3 is subsequently deposited, line 48, column 17.

Regarding claim 2, McTeer teaches the temperature of 700 degrees or less in line 45, column 17 falls in 250-550 range.

Regarding claim 5, McTeer teaches subjecting the barrier layer to greater than 200 degrees as temperature of 700 degrees or less lines 44-45, column 17; for 30-100 seconds namely less than 5 minutes, line 45 column 17.

Regarding claim 6, McTeer teaches dual damascene in lines 28-29 column 18, dual damascene carries all limitations of claim 6.

Regarding claim 8, McTeer teaches barrier metal layer chosen from group consisting of TiN and TaN, since McTeer teaches TiN and TaN, line 62-64, column 17.

Regarding independent claim 9, McTeer teaches all limitations as mentioned for claims 1, with addition of trench since McTeer teaches damascene claim 6,and the barrier comprises TiN also as mentioned for claim 8, as per above.

Regarding independent claim 11, McTeer teaches damascene in column 18, whereas damascene especially dual damascene, has opening width of 0.13 υm associated.

Regarding independent claim 21, McTeer teaches a partially finished device includes a barrier metal layer, line 24, column 17 on substrate; subjected the barrier layer to temperature greater than 200 degrees as temperature of 700 degrees or less lines 44-45, column 17; subjected to non-reactive atmosphere as hydrogen line 55, column 17; copper 3 is subsequently deposited, line 48, column 17.

Regarding claim 22, McTeer teaches non-reactive atmosphere chosen from the group consisting essentially of ambient vacuum, hydrogen gas, argon gas or helium gas since McTeer teach a hydrogen gas in line 55, column 17.

Claim Rejections - 35 USC § 103

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9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

10. Claims 9-12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Itoh et. al. (USPN 6,455,421 B1) in view of Nguyen et. al. USPN 5,851,367.

Regarding claim 9, Itoh, et. al. disclose integrated circuit structure at different stages of fabrication sequence (lines 17-18, column 4) that includes a tantalum nitride (TaN) barrier layer, (line 19, column 4). The barrier layer is subject to a pre-treatment as described in lines 24-42, column 5: chamber pressure of

Direct message to Danek

about 0.1 torr to about 100 torr (line 38, column 5), is an ambient vacuum; hydrogen gas (line 28, column 5), argon gas (line 27, column 5), and helium gas (line 28, column 5); a temperature 200°C to about 600°C is indicated in line 37, column 5 which is a range greater than 200 degrees Celsius; for a time period of less than about 300 seconds (line 42, column 5), is a time period that includes "at least thirty seconds". Itoh et. al. disclose the subsequent deposition of the copper in lines 7-8, column 6. Itoh et. al. fails to disclose TiN. TaN and TiN are mentioned interchangeably in the art to comprise the barrier layer to prevent the diffusion of Copper. See lines 46-50, column 6 in Nguyen et. al. It was commonly known to those of ordinary skill in the art that TiN could be substituted for TaN for the barrier layer. It would have been obvious at the time the invention was made to a person having ordinary skill in the art to incorporate the common knowledge that TiN could also be used as the barrier layer for the purpose recognized in the art of Itoh et. al., as discussed above.

11. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Danek et. al. as applied to claim 1 above.

Regarding claim 6, Danek et. al. show a test structure in Fig. 6 inset but fails to show that structure with limitations of claim 6, however Danek et. al. refer to damascene trench fill in lines 53-54 column 4, *that includes the limitations of claim 6*, and therefore it would have been obvious at the time the invention was made to one having ordinary skill in the art to apply the barrier treatment to the structure having damascene limitations since it could benefit by improved copper adhesion as indicated by Danek et. al. line 53,column 4.

12. Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Danek et. al. as applied to claim 1 above in view of Van et. al. USPN 6,567,541.

Regarding claim 7, Danek et. al. teach improved adhesion, line 53 column 4, are silent regarding the tape test. Van et. al. teaches that, "Early attempts to measure adhesion included the use of the tape test and a method of abrasion. The tape method consisted of pressing a piece of adhesive tape to the film. The tape

is then pulled off the film either leaving the film intact, removed in whole or in part, or remaining on the substrate. This method is qualitative only, and if the film remains on the substrate, it provides no quantitative data as to the magnitude of the adhesion forces. Failure of the tape test implies that the film is unsuitable for device fabrication." lines 6-14, column 2.

It would have been obvious at the time the invention was made to one having ordinary skill in the art to include adhesion properties such that said copper film remains adhered to said pre-treated barrier metal layer in order to make the device suitable for device fabrication since failure of the tape test implies that the device would be unsuitable for fabrication.

13. Claims 21-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tsai et. al. USPN 6,429,115. Tsai et. al. Teach barrier in lines 57-58 column 4, temperature of 350-450 degrees and duration 5-180 seconds (lines 20-21, column 4), and deposition of copper (lines 60-64 column 4). The cap layer can serve as the barrier layer (line 53-55, column 6). It would have been to one having ordinary skill in the art at the time the invention was made that since the cap can serve as the barrier layer the pre-treatment would serve the barrier layer.

Regarding claim 22, Tsai et. al. teach the chosen atmosphere is vacuum of 0.5 torr-10 torrs.

Conclusion

14. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL.** See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of

the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

15. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure: Levine USPN 5,989,999 teach of different gases line 37, column 4. Woo et. al. 6,548,395 teach partially filling the trench with copper before annealing 100.degree. C. to about 450.degree. C. for about 2 minutes to about 1 hour with nitrogen, hydrogen and helium mix. Levine et. al. USPN 5,989,999 teach subjecting the barrier layer to plasma atmosphere in lines 36-42, column 4 using nitrogen and hydrogen; and nitrogen and helium. Mori et. al. USPN 6,303,495 teach exposing copper nuclei to treatment. The examiner notes that tables 1 and 2 in Kobayashi et. al. USPN 6,562,219 are exemplary format of evidence qualifying a tape test. Ciotti et. al. USPN 6,509,266 teach barrier tantalum, line 14, column 6, non-reactive atmosphere argon line 16, column 6, is silent regarding temperature and duration of thirty seconds. Copper is deposited line 40-41 column 6. Also, Ciotti et. al teach hydrogen gas anneal under vacuum in line 17, column 5. Similarly, Kim 6,475,913 teaches vacuum, hydrogen, hydrogen/nitrogen or hydrogen/argon thermal treatment, lines 55-56, column 2. Gas is used to clean barrier in Tsubouchi et. al. USPN 6,495,461 line 6 column 9. Examiner notes Nguyen et. al. (common inventor and common entity) USPN 5,851,367 for non-reactive treatment.

16. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Michael K. Luhrs whose telephone number is 703-305-2864. The examiner can normally be reached on M-F; 8:00 a.m. - 5:00 p.m. (other Fridays off)..

17. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Richard T. Elms can be reached on 703-308-2816. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

18. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

Michael K. Luhrs
May 27, 2003

RICHARD ELMS
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800